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SCIENCE

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FRIDAY, MAY 10, 1918

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SCIENCE

FRIDAY, MAY 10, 1918

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THE INDUSTRIAL FELLOWSHIPS OF THE MELLON INSTITUTE¹

I HAVE the honor, in the absence of Dr. Raymond F. Bacon, director of the Mellon Institute, who was commissioned as a lieutenant-colonel and is now in command of the Chemical Service Section of the National Army in France, to report to SCIENCE on the growth of the industrial fellowship system of the Mellon Institute, University of Pittsburgh.

During the past year, twenty-one members of the institute, including the director, as noted above, and an assistant director, Mr. William A. Hamor, who was commissioned as major and is aide to Lieutenant-Colonel Bacon, have entered government service in response to their country's call. The following is a list of the Industrial Fellows who have gone direct from the Institute into service:

F. O. Amon, First Lieutenant, Sanitary Corps.
H. S. Bennett, First Lieutenant, Sanitary Corps.
C. O. Brown, Captain, Ordnance Department.
A. S. Crossfield, First Lieutenant, Sanitary Corps.
R. F. Ferguson, Private, Ordnance Department.
G. F. Gray, Captain, Signal Corps.
R. B. Hall, Second Lieutenant, Chemical Service Section.
W. J. Harper, Second Lieutenant, Sanitary Corps.
C. E. Howson, First Lieutenant, Sanitary Corps.
C. N. Iry, Second Lieutenant, Engineers Corps.
E. H. Loeb, Second Lieutenant, Ordnance Department.

¹ For previous reports on this subject, see Duncan, SCIENCE, N. S., Vol. XXXIX. (1914), 672; Bacon, *ibid.*, XLIII. (1916), 453, and Bacon, *ibid.*, XLV. (1917), 399.

R. W. Miller, First Lieutenant, Sanitary Corps.
 L. H. Milligan, Second Lieutenant, Ordnance Department.
 R. V. Murphy, First Lieutenant, Sanitary Corps.
 B. H. Nicolet, Captain, Chemical Service Section.
 A. H. Stewart, Cadet, Aviation Section.
 H. L. Trumbull, First Lieutenant, Ordnance Department.
 W. E. Vawter, First Lieutenant, Sanitary Corps.
 C. L. Weirich, First Lieutenant, Sanitary Corps.

In a number of instances, industrial fellows at the Institute, through the patriotism of the donors of their fellowships, have been giving part or, in some cases, all of their time to work on war problems which have been assigned to the institute by the National Research Council. The results obtained on some of the industrial fellowships have had opportune application to some pressing war problems. On these fellowships, no money is being spared by the donors or the institute to make the results of service to the government.

The institute, in most cases, has been able to fill the vacancies on the industrial fellowships, which were caused by the fellows entering military service. However, the shortage of research men, of the type demanded by the industrial fellowship system, has forced the institute to hold in abeyance a number of very desirable research problems. It is gratifying to report that, notwithstanding the unsettled condition of the business world, an increasing number of industrialists are assigning prob-

lems on their processes and products to the institute.

The following table shows the number of industrial fellowships which have been founded in the institute from March to March of each year—1911 to 1918; the number of researchers or industrial fellows, as they are called, who have been employed on these fellowships; and the total amounts of money contributed for their maintenance by industrial concerns:

March to March	Number of Fellowships	Number of Fellows	Amounts Contributed
1911-1912	11	24	\$ 39,700
1912-1913	16	30	54,300
1913-1914	21	37	78,400
1914-1915	21	32	61,200
1915-1916	36	63	126,800
1916-1917	42	65	149,100
1917-1918	42	64	172,000

The number of industrial fellowships, noted in the table above, gives very little idea of the real scope of the service of the institute. At the present time there are six national trade associations which have fellowships in the institute. These associations have in their membership over two thousand firms. The institute especially welcomes fellowships from associations, as it is permitted in this way to be of service to a large number of companies which, individually, could not afford to found a fellowship. The institute is glad to note that national trade associations have been quick to realize the value of industrial research and are fostering it in a number of different ways.

The following is a list of the industrial fellowships in operation at the institute on March 1, 1918:

A LIST OF THE INDUSTRIAL FELLOWSHIPS IN OPERATION AT THE MELLON INSTITUTE ON MARCH 1, 1918			
Numbers and Names of Industrial Fellowships in Operation	Industrial Fellows, Names and Degrees	Foundation Sums and Dates of Expiration	
No. 92. Leather Belting ..	E. D. Wilson (Ph.D., University of Chicago).	\$3,800 a year.	April 1, 1918.
No. 95. Magnesia	G. D. Bagley (E.E., University of Illinois).	\$4,750 a year.	November 1, 1918.
No. 99. Glyceryl Phosphates	F. F. Rupert (Ph.D., Massachusetts Institute of Technology).	\$1,500 a year. Bonus: 10 per cent. of profits.	October 1, 1918.
No. 102. Fruit Juice	R. R. Shively (Ph.D., University of Pittsburgh).	\$5,000 a year.	April 1, 1918.

- No. 114. Enameling R. D. Cooke (M.S., University of Wisconsin). \$2,200 a year. April 1, 1918.
- No. 115. Bread H. A. Kohman (Ph.D., University of Kansas), Senior Fellow. \$7,500 a year. Bonus: \$10,000. March 1, 1919.
R. R. Irvin (M. S., University of Kansas). (Vacancy.)
- No. 116. Refractories R. M. Howe (M.S., University of Pittsburgh), Senior Fellow. \$6,000 a year. May 1, 1918. Bonus: \$500.
(Vacancy.)
- No. 117. Window Glass ... A. C. Nothstine (B.S., Ohio State University). \$3,000 a year. Bonus: \$2,000. June 1, 1918.
- No. 118. Leather Soling .. C. B. Carter (Ph.D., University of North Carolina). \$3,500 a year. June 4, 1918.
- No. 119. Iron Ore F. M. McClenahan (M.A., Yale University). \$3,000 a year. June 15, 1918.
- No. 120. Dental Products.. C. C. Vogt (Ph.D., Ohio State University). \$2,400 a year. Bonus: Royalty on sales. July 1, 1918.
- No. 121. Copper C. L. Perkins (B.S., New Hampshire College). \$5,400 a year. July 1, 1918.
J. W. Schwab (B. S., University of Kansas).
- No. 122. Soda C. W. Clark (Ph.D., University of Pittsburgh). \$3,500 a year. September 1, 1918.
- No. 123. Oil Harry Essex (Ph.D., University of Göttingen). \$10,000 a year. Bonus: \$10,000. September 1, 1918.
I. W. Humphrey (M.S., University of Kansas). (Vacancy.)
- No. 124. Cement E. O. Rhodes (M.S., University of Kansas). \$4,000 a year. Bonus: \$3,500. August 1, 1918.
- No. 125. Hair B. A. Stagner (Ph.D., University of Chicago). \$3,000 a year. October 1, 1918.
- No. 127. Collar H. D. Clayton (B.A., Ohio State University). \$2,800 a year. October 1, 1918.
- No. 128. Coffee C. W. Trigg (B.S., University of Pittsburgh). \$1,800 a year. Bonus: 2 per cent. of gross receipts. October 1, 1918.
- No. 129. Illuminating Glass A. H. Stewart (A.B., Washington and Jefferson College). (On leave of absence.) \$900 a year. October 1, 1919.
- No. 130. Food Container.. F. W. Stockton (A.B., University of Kansas). \$5,000 a year. October 16, 1918.
- No. 131. Gas J. B. Garner (Ph.D., University of Chicago), Senior Fellow. (Vacancy.) \$7,500 a year. September 15, 1918.
- No. 132. Yeast F. A. McDermott (M.S., University of Pittsburgh). \$12,700 a year. Bonus: November 1, 1918.
Ruth Glasgow (M.S., University of Illinois).
T. A. Frazier (B. Chem., University of Pittsburgh).
P. H. Brattain.
I. S. Hocker (B.S., University of Pennsylvania).
- No. 133. Glass E. E. Bartlett (Pet.E., University of Pittsburgh). \$3,000 a year. November 1, 1918.
- No. 134. Glycerine J. E. Schott (M.A., University of Nebraska). \$3,000 a year. November 15, 1918.
- No. 135. Fiber J. D. Malcolmson (B.S., University of Kansas). \$2,500 a year. November 15, 1918.
- No. 136. Copper G. A. Bragg (B.S., University of Kansas), Senior Fellow of all Copper Fellowships. \$5,000 a year. November 1, 1918.
(Vacancy.)
- No. 137. Toilet Articles .. L. M. Liddle (Ph.D., Yale University). \$3,500 a year. December 1, 1918.
- No. 138. Silicate M. G. Babcock (M.S., Iowa State College). \$2,500 a year. December 1, 1918.
- No. 139-A. Organic Synthesis G. O. Curme, Jr. (Ph.D., University of Chicago), Senior Fellow. \$10,000 a year. Bonus: \$5,000. January 1, 1919.
J. N. Compton (M.S., Columbia University).
H. R. Curme (B.S., Northwestern University).
E. W. Reid (M.S., University of Pittsburgh).
- No. 139-B. Organic

Synthesis	H. A. Morton (Ph.D., University of Pittsburgh), Senior Fellow.	\$5,000 a year. Bonus: \$5,000. January 1, 1919.
No. 140. Silverware	C. J. Herrly (B.S., Pennsylvania State College). H. E. Peck (B.S., Clarkson Memorial College of Technology).	\$2,500 a year. December 11, 1918.
No. 141. Insecticides	O. F. Hedenburg (Ph.D., University of Chicago).	\$3,000 a year. January 1, 1919.
No. 142. By-products Re- covery	Walther Riddle (Ph.D., University of Heidelberg).	\$3,000 a year. January 1, 1919.
No. 143. Coke	F. W. Sperr, Jr. (B.A., Ohio State University), Advisory Fellow. Marc Darrin (M.S., University of Washington). O. O. Malleis (M.S., University of Kansas). L. R. Office (B.S., Ohio State University).	\$7,000 a year. January 1, 1919.
No. 144. Fertilizer	H. H. Meyers (B.S., University of Pennsylvania).	\$3,000 a year. Bonus: \$5,000. January 5, 1919.
No. 145. Soap	(Fellow to be appointed.)	\$2,000 a year. January 5, 1919.
No. 146. Glue	R. H. Bogue (M.S., Massachusetts Agricultural College).	\$2,500 a year. January 5, 1919.
No. 147. Distillation	David Drogin (B.A., College of the City of New York). H. F. Perkins.	\$5,300 a year. January 18, 1919.
No. 148. Tobacco	W. B. Pattison (M.A., University of Nebraska).	\$2,100 a year. Bonus: \$2,000. February 1, 1919.
No. 149. Laundry	H. G. Elledge (M.S., University of Pittsburgh), Senior Fellow. K. R. Beach (A.B., Southwestern College).	\$5,000 a year. February 15, 1919.

It required the cataclysm of the Great War to bring men to realize fully the part which applied science is playing and, more particularly, will play in the life of nations. As men have come to know that everything in modern warfare is controlled in a large measure by science—no gun of large caliber is located or fired without its aid—so they have come to know that in the making of things—in the economy and progress of manufacturing operations—science must have a place, an important place too. With this idea in mind, institutions of learning and industries in this country, but more especially abroad, are investigating and studying methods to bring about co-operation between science and industry. The Mellon Institute is proud that, while very young, it has been a pioneer in the field. Its principal claim to distinction, apart from its contributions to specific industries, is based on the service it has been able to render to other institutions in demonstrating the practicability of a system which brings together science and industry for the development of a future and more gracious civilization.

The administration of the Mellon Institute is now constituted as follows:

Raymond F. Bacon, Ph.D., Director (on leave of absence);
Edward R. Weidlein, M.A., Associate Director and Acting Director;
E. Ward Tillotson, Jr., Ph.D., Assistant Director;
John O'Connor, Jr., M.A., Assistant Director;
William A. Hamor, M.A., Assistant Director (on leave of absence);
David S. Pratt, Ph.D., Assistant Director;
Martin A. Rosanoff, Sc.D., Head of the Department of Research in Pure Chemistry.

E. R. WEIDLEIN,
Acting Director

MELLON INSTITUTE OF INDUSTRIAL RESEARCH,
UNIVERSITY OF PITTSBURGH,
March 1, 1918

THE EFFECT OF CATTLE ON THE EROSION OF CANON BOTTOMS

To every explorer in the arid cañon country of southern Colorado the steep-walled arroyo trenched in the center of the flat alluvium bottom is a familiar sight. Its vertical banks many times twenty or twenty-five feet high in the soft crumbling soil are no mean impediment to travel and its sandy or stony bottom is a source of constant anxiety to the freighter. Every storm fills this miniature

gorge with a rush of turgid mud-laden water and even when the rain has passed there is in the air the continual dull crash of the caving banks. At places the arroyo fills all the cañon bottoms; at others it is a mere crack in a wide expanse of alluvium, but it is continually encroaching on the bottom land. The depth of the erosion varies greatly and is controlled apparently by the distance of bed rock from the alluvium surface (which is governed by the amount of alluvial filling that had taken place) and by a fixed minimum grade which is determined by the amount of overloading of the stream and the grade of bed rock. This minimum will become smaller therefore as the alluvium is gradually removed from the cañon bottoms. The maximum depth of erosion observed by the writer is twenty-five feet, the average is probably about ten feet. The former is reached in exceedingly narrow cañons such as the upper Chaquagua Cañon, and that of the Purgatoire in southeastern Colorado and Yellowjacket and Sandstone Cañons in southwestern Colorado. The arroyos are formed only along intermittent streams. The cañons of McElmo Creek and the Purgatoire River seem to have been dry at least part of the summer in the early days (although they now flow water all the year around) and for this reason they exhibit the arroyo at the cañon bottom.

The steepness of the alluvial banks testifies to the recent origin of these arroyos. What caused them to appear so suddenly? Rarely is it that the processes of erosion are disturbed yet it appears that the disturbance which caused these arroyos has taken place during the last sixty years. The settlers who first entered these cañons found the bottom lands low and rounded with no suggestion of an arroyo at the center. The writer has talked with pioneer ranchers both in southwestern and southeastern Colorado and on this point they are unanimous. The arroyos have developed since their advent. To this may be added this further physical evidence:

1. Along the bottoms of Yellowjacket, Sandstone and Hovenweep Cañons in southwestern Colorado the arroyos are cutting into the

ruins of Indian houses (stone) which are extremely old as they represent a civilization much like that of the Zuni while the Utes have occupied this region since the time of historic record. The houses were built on alluvial flats and it is only recently that the streams have cut into them.

2. Old roads and trails frequently cut straight across gullies which it is now impossible to cross. (Southeastern and southwestern Colorado).

3. Along the sides of the cañon wall where the alluvium has been completely removed from the cliff sides the imprint of roots still remains (Chaquagua Cañon—Southeastern Colorado.)

4. The fact that water is more abundant in the cañon bottoms now than previously seems to have a bearing on this subject. In the early days (1860-1865 in eastern Colorado) (1870-1880 in western Colorado) water appears to have been very scarce in these cañons. This would seem to be due to the water flowing under a heavy alluvium cover as the precipitation records indicate no perceptible climatic variation. The formation of these arroyos seems to have uncovered a number of these hidden flows of water.

5. No alluvial terraces are found. The cañon floor is usually very nearly flat. If these arroyos were cyclic, we should expect to find a series of terraces representing a series of stages in the erosion of this alluvium. Such is not the case, even in comparatively wide cañons. The usual cañon rock terraces represent cycles exceedingly remote when compared with the one under discussion.

Comparisons of the drawings and photographs of government reports of 1860 to 1870 with recent photographs confirm this hypothesis, as the older reports do not seem to show any arroyos like those now developed.

The development of these arroyos seems to have been, therefore, contemporaneous with development of ranching. To what must we ascribe them then? The writer believes they are caused by cattle. Cattle influence erosion in two ways: first by the wearing of trails; second by the destruction of vegetation.

Cattle make trails along the line of easiest passage, usually the center of a cañon. They differ from the wild animals in that they are not hunted by man and must not shun narrow confined places, but actually converge toward them. Their trails grow rapidly and the writer can recall many which are five feet wide and a foot and a half deep. These trails effect erosion in two ways. First they form channels for the passage of water; second because of the absence of vegetation they form channels of easy erosion. Their compact surfaces are also hard places for the water to sink into the soil. During a heavy shower it is noticeable that water starts to form pools in these trails long before the surrounding surface shows the slightest sign of having reached its saturation point. When the storm becomes heavy each one becomes a miniature torrent and rapid erosion takes place in much the same manner as it does on a steep country road and finally small gullies are worn. Where rounded gullies are already present the walls are broken down and the vertical-walled arroyo finally results.

The influence of cattle on the vegetation of cañon bottoms as a whole is rather difficult to estimate, yet it must be considerable. The writer has seen in cañon pockets inaccessible to cattle deep grass so matted and tangled as to preclude any thought of erosion and cause maximum absorption, while in the same cañon where the cattle have ranged, the bottom is nothing but a tramped field of dust which offers maximum opportunity for erosion and minimum opportunities for absorption. This is particularly true in the mid summer and autumn months when cloud-bursts are frequent. We may, therefore, summarize the effect of cattle by saying that they increase the rapidity of the run-off and the rate of erosion by destroying vegetation, by compacting the soil and forming channels for the passage of water.

The introduction of this new element produced a disturbance in the nicely balanced forces of erosion so that the alluvial flats of the cañon bottoms were no longer planes of equilibrium. The increased volumes of water

that swept down the cañons demanded larger channels. These the trails and the small gullies which grew from the trails, supplied, until finally the process formed the arroyos we meet to-day. The present cycle is one of readjustment. In wide cañons the alluvium will be cut away until the width of the stream course becomes so great that water will lack the force to erode and the final channel will be a rounded one of somewhat lower grade and much closer to bed rock than the present one. In narrow cañons the alluvium will be entirely removed (along Chaquaqua Creek this has already taken place) and the stream erosion grade will be formed. Of course this process is small by the side of the great base leveling which is taking place in these regions, but it is interesting in that it shows the extreme nicety with which the forces that erode are balanced. It also shows rather forcibly one of the effects of the influences of human industry on the topography. Its economic effect is not as great as that of deforestation, but it will result in the ultimate abandonment of many small farms along some of the streams. For these reasons it is deserving of further investigation.

JAMES TERRY DUCE

UNIVERSITY OF COLORADO

AN EMERGENCY SUPPLY OF RUBBER

THE department of botany of the University of California has undertaken a study of certain West American shrubs belonging to *Chrysothamnus* and other genera of the Compositae to determine whether or not an emergency or supplementary supply of rubber exists in such native plants. This investigation is one of the projects of the botanical subcommittee of the Pacific Coast Research Conference acting under the Council of Defense of the State of California. Results thus far obtained indicate that the total amount of rubber present in these native species is considerable, but that the percentage yield of individual plants is too small to render its extraction profitable at present prices. If, however, the importation of raw rubber should be curtailed through enemy action, this emergency supply existing within

the border of the continental United States could be utilized. It might be noted here that the quality of this new rubber is, according to rubber experts, somewhat better than the best grades of guayule, but not as good as Para.

The choice of *Chrysothamnus* and related genera as the plants first to be investigated was the result of a preliminary examination made in 1904. In September of that year the late Judge A. V. Davidson, of Independence, Inyo County, California, sent some twigs to the Department of Botany for identification, with the information that the Indians prepared from the plant a sort of "gum" which they chewed. The plant was a species of *Chrysothamnus* of the *graveolens* group. Further samples were submitted at our request, and in October, 1905, a preliminary chemical examination of them was made by Professor G. E. Colby, of the California Experiment Station. This examination indicated the presence of rubber, but not in sufficient amount to warrant further investigation. A report to this effect was made public in the press and as a result some further examinations were made by at least one commercial rubber company. The matter was soon dropped, however. It is probable that the plants used in this commercial examination were of an entirely different species from those now being examined.

During the past year some 200 different plants have been studied in detail, both in the field and in the laboratory. As a result it can now be definitely stated that many species of *Chrysothamnus* (formerly known as *Bige-
lovia* and commonly called rabbit-brush, or golden-bush) carry rubber in at least small quantities and that it occurs also in three species of *Ericameria* and in one species of *Stenotus*.

One species of *Ericameria* carries 9.5 to 10 per cent. of pure rubber, in addition to about 9 per cent. of acetone-extractable resins, etc. Although this plant possesses agricultural possibilities, it is too small and occurs too sparingly to be considered as a source of wild rubber. In six species of *Chrysothamnus* the older parts carry from 3 to 5 per cent. of rubber. This percentage is for dry rubber

and does not include the resins or other acetone-soluble impurities. The term "species" is here used in a narrow sense. The six species referred to are all allies of *C. nauseosus*, *C. graveolens*, or *C. teretifolius*. Further taxonomic studies will be necessary before final determinations can be made, since some of the forms do not correspond to any of the described species.

The most important of these species is a large shrub, the rubber-producing portions of which commonly weigh from two to ten pounds, with a maximum observed weight of about sixty pounds. It forms nearly pure stands of considerable extent in some parts of the Great Basin Area. Histological examinations indicate that the rubber content is fairly uniform throughout its distribution. Much care must, however, be exercised to avoid confusion with closely similar forms, some of which exhibit marked fluctuation in their rubber content, while others uniformly carry not even a trace of this substance. Professor P. L. Hibbard, of the California Experiment Station, who has made the chemical analyses, reports for the most important form as follows:

	Acetone Extract, Per Cent.	Benzol Extract, Per Cent.
Plant 1, base of stem	3.74	5.06
Plant 2, base of stem	3.90	4.40
Assorted plants, trunk and root bark	3.90	7.80

These figures are for fairly dry shrub. If based upon perfectly dry shrub the percentages would be somewhat higher.

Field experiments have been instituted to determine the possibility of inducing a greater growth of the rubber-bearing tissues and also to determine whether or not it is feasible to harvest the rubber without killing the plants. Some attention is also being paid to the possibility of bringing the plants under culture for commercial purposes.

It is now proposed greatly to extend the scope of the investigation and to include many more species. In addition to locating the principal supply of the more promising species and its extent, we hope to study more inten-

sively their ecologic behavior, seasonal variation, reproduction, and other points of scientific as well as economic interest. We shall, therefore, be extremely grateful for samples from any district in which the plants grow, and shall be pleased to send instructions for the taking of these. However, even a small portion of the basal part of the stem will be helpful, since this will enable us to make a preliminary examination to determine the desirability of securing more abundant material.

The above partial outline of the results thus far obtained will be followed in due time by a detailed report on our studies.

HARVEY MONROE HALL,
THOMAS HARPER GOODSPEED

DEPARTMENT OF BOTANY,
UNIVERSITY OF CALIFORNIA

SCIENTIFIC EVENTS

BRITISH CIVIL SERVICE ESTIMATES FOR SCIENCE AND EDUCATION

THE Parliamentary Paper dealing with Class IV. of the Estimates for Civil Services for the year ending March 31, 1919, is summarized in *Nature*. A special grant of £30,000 is included in aid of certain universities, colleges, medical schools, etc., to meet loss of income arising from circumstances of war. It may be remembered that the Estimates for 1915-16 included a similar grant of £145,000 for the same purpose. The grant for the National Physical Laboratory has been transferred from the head of the Royal Society, under which it formerly appeared, to that of the Department of Scientific and Industrial Research. It amounts to £89,750, being an increase of £64,475 upon the grant for 1917-18. The state receives, however, for testing fees and other services rendered by the laboratory the sum of £11,250, and £3,000 as contributions from cooperating bodies. The new Fuel Research Station has a grant of £7,000, of which £4,000 is required for salaries and wages, and £3,000 for apparatus, materials, etc. The grants made by the Department of Scientific and Industrial Research amount to £56,500, in comparison with £30,000 in 1917-18. The salaries, wages and allow-

ances of the department are estimated at £8,900.

The following gives the grants in summary:

UNITED KINGDOM AND ENGLAND

	£
Board of Education	19,206,705
British Museum	126,142
National Gallery	11,639
National Portrait Gallery	3,779
Wallace Collection	4,012
London Museum	2,300
Imperial War Museum	19,000
Scientific Investigation, etc.	54,241
Department of Scientific and Industrial Research	148,350
Universities and Colleges, Great Britain and Intermediate Education, Wales..	321,700
Universities, etc., Special Grants	30,000

Scotland

Public Education	3,041,545
National Galleries	4,283

Ireland

Public Education	2,203,104
Intermediate Education (Ireland)	90,000
Endowed Schools Commissioners	855
National Gallery	1,830
Science and Art	163,393
Universities and Colleges	96,350
Total	25,529,228

The appropriations for scientific institutions are as follows:

	£
British Museum	90,022
Natural History Museum	44,045
Imperial War Museum	19,000
Royal Society	6,000
Meteorological Office	22,500
Royal Geographical Society	1,250
Marine Biological Association of the United Kingdom	500
Royal Society of Edinburgh	600
Scottish Meteorological Society	100
Royal Irish Academy	1,600
Royal Irish Academy of Music	300
Royal Zoological Society of Ireland	500
Royal Hibernian Academy	300
British School of Athens	—
British School at Rome	500
Royal Scottish Geographical Society	200
National Library of Wales	3,200
National Museum of Wales	7,500
Solar Physics Observatory	3,000

School of Oriental Studies	4,000
North Sea Fisheries Investigation	—
Royal College of Surgeons in Ireland	500
Edinburgh Observatory	1,691

SCIENTIFIC AND INDUSTRIAL RESEARCH

Grants for investigation and research	56,500
Fuel Research Station	7,000
National Physical Laboratory	89,750

THE AMERICAN MEDICAL ASSOCIATION AND THE WAR

A war conference of secretaries of the constituent State Associations of the American Medical Association was held at the headquarters of the association on April 30. From the *Journal* of the association we learn that the meeting was called to order by Dr. Alexander R. Craig, secretary of the association. Dr. Thomas McDavitt, of St. Paul, chairman of the board of trustees, was elected chairman, and Dr. A. R. Craig, secretary. Dr. McDavitt emphasized the great importance of the meeting. He said the government had made a new call for physicians. There are already in the service, in the different corps, at the present time about 20,000 physicians. The issues involved are so great that the government is anxious to have an excess if possible. The 5,000 physicians that are requested now do not provide for an excess.

Dr. Arthur Dean Bevan, president-elect of the association, spoke of the importance of a survey of every state with a view of recording exactly how many medical men there are in each state, and how many have applied for commissions in the Medical Reserve Corps. This work, he said, can be perfected, as is contemplated and as requested by the Surgeon-General of the Army, by the American Medical Association through its county and state societies.

Dr. Charles Mayo, president of the association, said:

The medical profession was almost the first to become well organized before the war began, because we have had an organization for a long time. So far as the association is concerned, it was easy for organized medicine to get the names of the men we needed to do their bit. In fact, they had

been doing their bit by going over to help Britain, France and Serbia in every possible way.

Our profession is organized, but around the outskirts is a great deal of disorganization that has been held over from the methods of the profession in advancing their work in education. In the early period there were in Washington about eighteen bureaus, boards and departments that had to do with medicine. Each of these bureaus and departments spends a great deal of money, and there is absolutely no coordination and no one will let go. Each head wants to be chairman of the committee to look after it. The more we study the question, the more we find that there will be no change until we get a real department of health with an officer in the cabinet to look after it, and then we will have an organization.

A serious problem comes to mind in relation to France. There they have not had any medical schools running for four years. In England the same thing is true. With the natural death rate of doctors and no new degrees granted, it means a great deduction, and the danger that when the schools have started again, there will be lowered standards. I think organized medicine in this country did great service in seeing to it that the government did not in developing draft laws break up the medical schools. I think that has been one of the greatest features shown by organized medicine.

The thing I have been hoping for is that funds may be obtained to develop a great medical teaching institution in Paris. From letters received from the French government, the president and others high in authority, this idea is approved. We could move our men over there a thousand at a time and they could be trained by men at the front who for four years have had at their fingers' ends things that we can not possibly get in this country. I would suggest to turn over now for teaching purposes two thirds to the Americans and one third to France, and after the war make France a present of it, and make Paris the center for American medical study in Europe. It takes a lot of money to run such an institution, but it looks as though the money might be raised. It is estimated that it would take from \$100,000 to \$150,000 under present circumstances to run such a school for a year. It is most difficult to bring about such a thing under government control. Something like that must be planned by organized medicine, but not by government organized medicine, and turned over to the Surgeon-General for the period of the war. Surgeon-General Gorgas could easily detail

men in the service for temporary duty for the education of these men and give them one month or two months of lectures, and without disorganization we could give our surgeons the absolutely necessary instruction and all around service we have been trying to develop in a more or less haphazard way.

THE INTERALLIED SCIENTIFIC FOOD COMMISSION

At an interallied conference, which was held last November in Paris, it was agreed, according to the *British Medical Journal*, that a Scientific Food Committee should be formed containing two delegates from each of the following countries: Great Britain, France, Italy and America. This committee was to have its permanent seat in Paris, and was to meet periodically in order to examine, from the scientific point of view, the interallied program for food supplies. It was empowered to make any propositions to the allied governments which it thought fit. The delegates appointed from the various countries were: Great Britain: Professor E. H. Starling and Professor T. B. Wood; France: Professor Ch. Richet and Professor E. Gley; Italy: Professor Bottazzi and Professor Pagliani; America: Professor R. H. Chittenden and Professor Graham Lusk. The first meeting of this Commission was held in Paris on March 25, and the following days. At their first sitting the commission was received by M. Victor Boret, minister of agriculture and food. In his opening address M. Boret pointed out that the object of the conference was to study the best means of utilizing the very small food resources at the disposal of the allies so as to effect an equitable distribution of the available food supplies among the allies, having proper regard to the facts of physiology and political economy. He sketched shortly the work of the commission, and his suggestions were embodied later in a series of questions which were adopted by the commission as the problems that would immediately occupy its attention. The commission agreed to establish a permanent central secretariat in Paris, M. Alquier being appointed secretary. In addition to the central secretariat it was agreed that a secretary to the commission should be

appointed in each of the allied countries. At its meetings, which lasted till March 29, the commission considered many important questions relating to the minimum food requirements of man, and to the production and distribution of food supplies. The commission will reassemble at intervals, in Paris or in some other of the allied capitals. Professor Gley has stated that it will probably meet next at Rome towards the end of this month.

SCIENTIFIC NOTES AND NEWS

PROFESSOR DUGALD C. JACKSON, of the department of electrical engineering of the Massachusetts Institute of Technology, has been called to France as a major in the Engineer Reserve Corps.

PROFESSOR PHILIP B. WOODWORTH, dean of electrical engineering of Lewis Institute, Chicago, has entered the government service as a major in the aviation section of the Signal Corps.

DR. H. E. WELLS, professor of chemistry at Washington and Jefferson College, has been commissioned captain in the Chemical Service Section of the National Army.

DR. GEORGE WINCHESTER, professor of physics of Washington and Jefferson College, has been commissioned first lieutenant in the aviation section of the Signal Corps, and is now in France.

MR. LAWRENCE ERICKSON has resigned an instructorship in botany in the New York State College of Agriculture and has enlisted in the Coast Artillery.

DR. LEWIS KNUDSON, professor of botany in the New York State College of Agriculture, has obtained a leave of absence and is now in Y. M. C. A. work in France.

CALVIN H. CROUCH, who for seventeen years has been at the head of the mechanical engineering in the University of North Dakota, has accepted a position at Mt. Holyoke, Mass., with the Deane Plant of the Worthington Pump and Machinery Corporation, which is making war material for the government.

J. ANSEL BROOKS, professor of mechanics and mechanical drawing at Brown University, has

entered the engineering section of the aviation service, and is stationed at Lake Charles, La.

MR. WATSON BAIN, professor of applied chemistry at the University of Toronto, has been granted leave of absence for the duration of the war. He is going to Washington, D. C., where he will be on the staff of the Canadian mission.

E. A. RICHMOND, instructor in physiology at Simmons College, has joined the Signal Corps. At present he is doing research work in physiology at the Medical Research Laboratory in Mineola, N. Y.

DR. WALTER M. MITCHELL, formerly of the astronomical department of the University of Michigan, and recently mechanical engineer with the Midvale Steel Co., Philadelphia, has received an appointment in the Signal Corps, U. S. A. Dr. Mitchell is stationed at Rochester, N. Y., and is placed in charge of the inspection of equipment for the Signal Corps in that district.

DR. A. D. BROKAW, assistant professor of mineralogy and chemical geology at the University of Chicago, has been called to Washington to take charge of the oil production east of the Rocky Mountains.

DR. E. B. SPEAR, professor of chemistry of the Massachusetts Institute of Technology, has been appointed consulting chemist to the Bureau of Mines in connection with the gas warfare work.

P. W. MASON, assistant professor of entomology in Purdue University, has resigned to accept a position in the Bureau of Entomology, U. S. Department of Agriculture, Washington, D. C.

R. V. MITCHELL, professor of poultry husbandry at Delaware College, has been granted leave of absence to do work with the U. S. Food Research Laboratory along the line of poultry and egg handling.

DR. C. L. REESE, of E. I. du Pont de Nemours & Co., has been named chairman of the committee on dyestuffs and intermediates of the Chemical Alliance.

DR. CHARLES KEYES, consulting mining engineer and geologist of Des Moines, has been

chosen by the Democrats of Iowa for candidate for United States senator, to succeed Senator W. S. Kenyon, whose term expires shortly.

DR. ROYAL S. COPELAND has been appointed by Mayor Hylan to be health commissioner of New York City.

DR. H. E. DUBIN has resigned as chemist to the Montefiore Home and Hospital to accept the appointment of research chemist with the Herman A. Metz Laboratories, Inc., New York City.

AFTER thirty-eight years' service, Mr. Richard Hall has retired from the staff of the geological department of the British Museum.

CAPTAIN ROALD AMUNDSEN proposes to leave Norway this summer in his new Arctic vessel, the *Maud*, which has been specially built for this attempt to reach the North Pole. The vessel is to be provisioned and fitted out for a seven years' stay in the ice, but Captain Amundsen hopes to be back within four years.

PROFESSOR J. H. JEANS, the physicist, has been elected a member of the Athenæum Club for distinction in science.

PHILIP E. EDELMAN, of St. Paul, Minn., has been awarded the Research Corporation fellowship in applied science on competition by a jury consisting of the president of the National Academy of Sciences, the secretary of the Smithsonian Institution, the president of the American Chemical Society, the president of the Research Corporation and the chairman of the Engineering Foundation, upon evidence of scientific attainments, inventions and special fitness for advanced work. Mr. Edelman is an electrical engineering graduate of the University of Minnesota and has served as electrical engineer for radio-communication interests. He is the author of "Experimental Wireless Stations" and other popular technical books, and has since February, 1917, devoted his time principally to research work for the government.

DR. RAYMOND PEARL, of the United States Food Administration, lectured on May 9 at the Washington Academy of Sciences, the subject of the lecture being "Biology and War."

DR. F. G. NOVY, professor of bacteriology and director of the hygienic laboratory, University of Michigan, addressed the Cincinnati Research Society, in the surgical amphitheatre of the Cincinnati General Hospital, on May 1, on "Blood Changes and Anaphylaxis," and on May 2, on "Blood Parasites."

At the meeting of the Chemical Society at London, on April 18, the first of the Hugo Müller lectures was delivered by Sir Henry Miers, whose subject was "The Old and the New Mineralogy."

GIRTON COLLEGE, Cambridge, plans to found a fellowship for the encouragement of research in natural science, and especially in botany, as a memorial of Miss Ethel Sargant.

A BRONZE bust of the late Dr. Daniel Giraud Elliot, mammalogist and ornithologist, is installed on the second floor of the American Museum, in the hall devoted to birds of the world. The bust, which is the work of Mr. Chester Beach, is the gift of Miss Margaret Henderson Elliot, daughter of Dr. Elliot.

DR. EPHRAIM FLETCHER INGALS, professor of diseases of the chest, throat and nose in the Rush Medical College, Chicago, and active in medical research and organization, died on April 30, aged seventy years.

DR. ARMAND THEVENIN, of the Sorbonne, known for his work in paleontology, died on March 7, aged forty-eight years. He had been experimenting with poisonous gases and in the course of his work contracted the illness which proved fatal.

MR. W. HAGUE HARRINGTON, one of the best known of the older Canadian entomologists, died on March 13 at Ottawa, Canada, at the age of sixty-six years. Mr. Harrington was born in Nova Scotia, and entered the federal civil service at Ottawa in November, 1870, eventually reaching the rank of superintendent of the Savings Bank Branch. He was one of the founders of the Ottawa Field Naturalists' Club, and at one time was president of the Entomological Society of Ontario. In 1894, he was elected a fellow of the Royal Society of Canada. For many years his main interest in life was entomology, and he brought together

a large collection of Canadian Coleoptera and Hymenoptera. He was a systematist of recognized standing, and was probably the highest authority on Hymenoptera in the Dominion of Canada. He was a striking example of that class of men who have done pioneer work in natural history in Canada and the United States, while pursuing this work as a hobby rather than as a vocation.

UNIVERSITY AND EDUCATIONAL NEWS

THE Kentucky legislature in the session ending on March 15 made a notable change in the laws providing for the support of institutions of higher education. In view of the material increase in the state's property assessment by the tax commission the legislature passed the reapportionment tax bill and gave the university a rate of $1\frac{3}{4}$ cents on each hundred dollars of the assessment. This provision will give the university an increase of \$200,000 annually over the income it has had in previous years. Plans are now under way for a material increase in the teaching staff and the undertaking of extensive repairs in the plant of the university. Olmstead Brothers, of Brookline, Mass., have been employed to work out plans for campus improvements. Due to war conditions, no new buildings will be constructed at present. President McVey, formerly of the University of North Dakota, began his service with the University of Kentucky last September.

ANNOUNCEMENT is made of the completion of the diamond jubilee fund of \$800,000 for the Ohio Wesleyan University.

A NEW chemistry building is to be erected on the campus of the University of North Dakota. The ground has already been broken and contracts for the construction of the building have been let by the State Board of Regents, at a cost of \$62,483.

At a recent meeting of the council of the University College of Wales, Aberystwyth, it was reported that an anonymous donor was prepared to transfer the sum of £10,500 to the college for the purpose of endowing a chair in geography and anthropology. Herbert John

Fleure, who was appointed professor of zoology at the college ten years ago, will now devote all his energies to the department of geography.

DR. R. H. JESSE, JR., head of the department of chemistry at the Montana State University at Missoula, has been appointed dean of men for the institution.

DISCUSSION AND CORRESPONDENCE

ASTIGMATISM AND COMA

PERHAPS the clearest statement of the prevailing theoretical distinction between the five spherical aberrations is that given in the last edition of the *Encyclopedia Britannica* by Dr. Eppenstein of the Zeiss factory.

The differentiation there made between astigmatism and coma is not, however, in strict conformity with the facts. The term "astigmatism" as applied to lenses has always referred to the increasing lack of sharpness in the image towards the edge of the field in an uncorrected or poorly corrected lens system and "coma" to the peculiar radial flare sometimes very evident in the outer portions of the field.

The explanation given in the article just referred to is that astigmatism is the aberration due to obliquity and is therefore fully shown by very narrow bundles of rays, while coma can not be shown at all except with a wide bundle.

This explanation is the result of reasoning from the theory of astigmatism devised by Sturm, who assumed a behavior of oblique rays completely at variance with the facts. By the use of a method developed by the writer it is possible to calculate with strict accuracy the path and focal point of any ray through a lens surface from any point of the field by the use of which it became at once evident that the two foci calculated by Sturm's method locating the position of the two astigmatic surfaces are pure fictions; though this calculation is nevertheless a rough numerical approximation of this aberration. The detail of the new method of calculation will be presented elsewhere.

As a matter of fact only distortion and curvature are independent of the bundle width,

and both coma and astigmatism are increased with increase in the width of the ray bundles, and it is not true, as stated in this article, that coma alone is the result of the width of the ray bundle. This can be very easily proven without recourse to mathematical calculations by the use of a poorly corrected photographic lens, examining the images on the ground glass or making photographs of a grating, using a wide and a narrow stop.

The best known test for astigmatism is the fact that where this aberration is uncorrected one of two crossing lines may be very vague, while the other is sharp and distinct. This is best seen with the wide stop. The effect is usually explained according to the Sturm theory by saying that only one of these lines can be in focus at a time and that either may be brought into focus. If one will shift the ground glass he can easily prove that only radial lines can be sharply focused by an uncorrected lens, and that towards the edge of the field lines at right angles to these radial lines can not be brought into focus at all and are in fact most nearly in focus on the same plane as the radial lines.

When the grating is rotated 90° the lines that were vague may become sharp but only when a line is approximately radial is the effect of astigmatism nullified.

Both astigmatism and coma consist in a longitudinal spreading out of the image produced by the zones of the lens. The radial lines remain sharp because the shifting is radial and the shifted images of a radial line are superimposed, the line remaining sharp because its width is not increased to an appreciable extent.

Instead therefore of making the distinction expressed by Dr. Eppenstein that the features of lateral aberration due to obliquity constitute astigmatism, and that those dependent on difference of zones produce coma, the writer would suggest that the former be defined as the difference of focus produced by the median region of the lens and that of the most distant marginal point while the latter represents the focal difference of the nearest marginal point of the lens.

The reasons for these new suggestions are: (1) That the sharpest focus is normally produced by the central portion of the lens and lateral aberrations depend on differences of focus that may result from the passage of light rays through a marginal region of the lens; (2) that the best measure of lateral aberrations are the extreme deviations, and these are those of a point at the edge of the object field through the nearest and through the most distant marginal point of the lens; (3) that the greatest difference of focus of a lateral object between the central image and that produced through an edge point is the one produced by the most distant point on the lens surface and therefore this may most appropriately be designated astigmatism; (4) that the focus through the nearest marginal point of the lens may lie on either side of the median focus and if on the same side as that of the distant marginal point there is produced the characteristic optical effect called coma, and finally (5) that these two measurements are strictly comparable with the measurement always made to determine the longitudinal aberration of the axial rays and are therefore the only consistent methods of determining the two lateral aberrations.

C. W. WOODWORTH

UNIVERSITY OF CALIFORNIA

OBSERVATIONS ON THE AURORAL CONVERGENT, APRIL 5, 1918

AN auroral display of more than usual interest occurred on Friday evening, April 5, 1918, and was observed by the writer from a point about one and a half miles southeast of the Dominion Observatory, Ottawa.

At about 10.30 P.M. the rays seemed to be converging at a more or less well-defined point approximately half way between Saturn and the "Big Dipper." For all that the writer knew the position or path of the point of auroral convergence and its height above the earth's surface had been subject to such frequent observation that any measurements he might make on this particular evening would be superfluous, but they seemed to him more worthy of record for a scientific magazine than

the random descriptions of color, play of light and duration which have recently appeared and he decided to see whether or not the position of the point of convergence could be determined with any degree of accuracy.

Exact Western Union time was obtained from "central," but the rough nature of the observations makes the times recorded below approximate only, say within one minute, the fact that they are recorded as 11.20 and 11.40 being due not to rough estimation but to choice. The writer used a clothes reel with taut wires, revolving it so that one of the wires intersected both Saturn and the point of convergence. Three small markers ($\frac{1}{2}$ inch wide) were hung on the wire and moved about until they covered Saturn, the point of convergence (convergent), and another known point or star, all in line.

The following observations were made:

10.55 P.M. Saturn, convergent, and Mizar in line.

Saturn to convergent: convergent to Mizar
:: 11 $\frac{1}{2}$: 10 $\frac{1}{4}$.

11.20 P.M. Saturn, convergent, and star at end of handle of "Big Dipper" in line.

Saturn to convergent: convergent to star
:: 11 $\frac{1}{2}$: 8 $\frac{1}{2}$

11.40 P.M. Saturn, convergent, and point in sky on line from Mizar through end of "Big Dipper" handle and the barest fraction (say one sixth) farther from the end of the handle than that is from Mizar, all in line.

Saturn to convergent: convergent to point
:: 13 $\frac{1}{2}$: 7

11.55 P.M. Saturn, convergent, and Gamma of Bootes in line.

Saturn to convergent: convergent to Gamma
:: 15 $\frac{1}{2}$: 7 $\frac{1}{2}$

For the last observation (11.55 P.M.) the rays of light had become faint enough to make the exact position of the convergent somewhat doubtful and measurements were discontinued. In fact the latter observation was taken at 11.55 instead of at midnight, which would have preserved the 20-minute interval, because of a fear that the position of the convergent would become too indistinct for observation.

There was a perceptible tendency for the

light near the convergent to arrange itself in the form of an hyperbola, but no definiteness in the position of the axes could be detected other than a tendency for the visible hyperbola to occupy a quadrant opening toward the north or northeast. At many times during the hour the auroral display covered large sections of the southern sky, and the writer can remember thinking of the peculiar lateral shifting of the curtain in certain auroras and wondering how this would look if it took place near the convergent, but saw no such movement. At times a shaft of light more or less meridional in direction lay across the convergent.

At the time the writer hoped that others were making similar observations and that it might be possible to determine the height of the point of convergence and he was somewhat surprised later to realize that his observations indicated the further fact of a change in the position of the convergent with reference to the stars which seemed only partly to be explained by their rotation. He only hopes that similar observations were made by others in different places and that the ones herein recorded are sufficiently accurate to make them of value. They at least have the merit of having been made by one who had no preconceived idea of what they might indicate, and who regrets, if they prove to have value, that he was unable to make use of more exact tools.

LANCASTER D. BURLING

GEOLOGICAL SURVEY,
OTTAWA, CANADA

THE DOMESTICATION OF THE LLAMA

TO THE EDITOR OF SCIENCE: A note in SCIENCE for March 15, 1918, by Mr. Philip Ainsworth Means, leads the reader to believe that the llama, alpaca, vicuña, and guanaco are distinct species and that the common belief is that all have been domesticated to some degree.

Prior to about 1890 there was great confusion regarding the specific status of these four animals, though the prevailing theory was that the llama had been derived from the guanaco and the alpaca from the vicuña. It is now known that the vicuña has never been domesticated, and that the alpaca and the llama are

both domesticated forms of the wild guanaco.¹ In view of the conspicuous differences between these two tame races of the guanaco it is easy to believe that a very long period of actual domestication has obtained, for the alpaca has been bred for his wool and the llama has been developed as a beast of burden as effectually as any of our races of domestic animals have been produced for special purposes by the most careful selective breeding.

The llama and the alpaca are not known in a wild state, though they of course occur, as do almost all other domesticated species, in a semi-wild or feral condition. They represent one of the rare cases of true domestication of an animal, and one of the still rarer cases where the ancestral species is known and still exists as a wild creature. Contrary to the statement in SCIENCE, they do breed freely in confinement; but since so many wild animals propagate regularly in captivity this can hardly be considered a test of true domestication.

N. HOLLISTER

NATIONAL ZOOLOGICAL PARK,
WASHINGTON, D. C.,

THE AUDIBILITY OF SOUND

REPLYING to the suggestion of Mr. Willard J. Fisher, in your issue of April 26, that an investigation be made of the area about Halifax with regard to audibility of the sound from the great explosion there, it may interest you to know that such an investigation was undertaken by the National Geographic Society not long after the occurrence of the explosion and that a quantity of data has been accumulated which is to be charted and tabulated as soon as other work will permit.

CHARLES E. MUNROE

SCIENTIFIC BOOKS

The American Indian. An Introduction to the Anthropology of the New World. By CLARK WISSLER, Curator of Anthropology in the American Museum of Natural History, New York City. New York, 1917. Pp. xiii, 435.

¹ Thomas, *Proc. Zool. Soc. London*, 1891, pp. 385-387.

It is now nearly thirty years since the appearance of Brinton's "American Race." Primarily an attempt at a linguistic classification, especially of the South American tribes, this volume gives in a very summary form a general survey of all the peoples of the New World. The generation which has elapsed since then has been extraordinarily prolific in the accumulation of new data, but until the publication of Dr. Wissler's volume, no serious attempt had been made either to gather together and correlate this great mass of new material, or to give a really adequate account of the peoples of America and their culture. The debt, therefore, which not only anthropologists but all who are in any way interested in the aborigines of the New World, owe to the author is great, for not only has he judiciously summarized and correlated the results of a host of special investigators, but he has drawn from these results general conclusions of wide importance, which gain greatly in their force by the careful consideration shown for the form and order of the presentation and discussion of the material.

The first thirteen chapters are given to a consideration of the major facts of the culture of the Indian throughout both continents. Beginning with the material culture, the fine arts, social grouping and regulations, ritualistic observances and mythology are treated in order. On the basis of these facts, the peoples of the two continents are grouped in fifteen culture areas, whose limits and characteristics are defined. Next the archeological data are summarized, with the result that twenty-four typical areas are recognized. Archeology having introduced the time element, such evidence as exists on the chronology of American cultures is presented, both dependent on stratigraphic as well as actual historic data. The linguistic and somatic characteristics and classifications are next passed in review, and the broad foundation thus completed for the suggestive and stimulating final three chapters. In the first of these the separate results of the classification on cultural, linguistic and somatic data are

correlated, and the influences and importance of migration and of environment are discussed. In the second, the larger questions of culture origins and of the association of culture traits are considered, with the resulting conclusion that culture must be studied and explained from the historical standpoint rather than the biological, which is here not applicable. Finally, in the concluding chapter, the ultimate questions of the origin and relationships of American culture and of the American peoples are outlined. Here the case for the virtual independence and purely local origin of New World culture is clearly and convincingly stated, although from the physical standpoint, the ultimate Asiatic origin of the Indian is demonstrated with equal force. In an appendix useful tables of linguistic stocks are given, bringing together for the first time in handy compass, the material for both continents. A selected bibliography, mainly of the more recent authorities, closes the volume.

It would be of little value to attempt to summarize in the space available, the great mass of material in the book; one can only point out a few of the more important general conclusions reached. One of these is this, that in the domain of material culture, the higher developments were nearly all concentrated in the area of intensive agriculture, and that it is probable that these higher cultural elements spread not singly, but often in association, *e. g.*, that the knowledge of and the making of pottery and textiles, spread with the use of agriculture. On the social side, the fundamental unity of type is pointed out, and evidence brought forward to show that clan organization, dual grouping, age-grades, secret societies and the totemic complex are not necessary stages in the evolution of society, but rather local developments, based on special conditions. This fundamental unity of the peoples of America and the independence of their culture is emphasized in many ways, and the point well made that all the varied attempts to derive the whole or portions of this culture from Asiatic or Polynesian sources, overlook the chrono-

logical factor, which in this case can be shown to be decisive. Perhaps the most suggestive portion of the volume is at the end, where Dr. Wissler brings out the ultimate common derivation of the American peoples and those of the great Mongoloid group in Asia. Summed up, his conclusions are that a detachment of the parent Mongoloid group came into America at a time when man had barely attained the stage of making polished stone implements. This period was not necessarily contemporaneous with the same development in Europe, for it may well have been even earlier. After this detached portion of the group had spread into the New World, climatic changes cut off the connection, and forced both the parent and the derived group toward the south. In the Old World, contact with other differentiated groups gave to the Asiatic branch culture stimuli; in the New World these were lacking, and the people developed in isolation. In the New World the rate of progress along the culture road was thus slower than in the Old, and we may well ask what another thousand years of uninterrupted growth would have produced.

Throughout the volume effective use is made of maps showing the distribution of the various features under discussion. If criticism were to be made of these, it would be in regard to the use of rigid rectilinear boundaries. In spite of the author's justification of this method on p. 242, it would seem that his purposes could have been equally attained by a little more adherence to the actual facts. It is also rather aggravating to find several cases where the map and the text do not agree. Thus on p. 59 it is said that the loom was probably developed in the area of intensive maize culture, and "from there it was diffused around the north coast of South America and down the east side," yet in the map, Fig. 20, there is no indication of its extension beyond western Venezuela. The plates and illustrations are in general excellent, but one may question the wisdom of reproducing the crude woodcuts from Wood's antiquated volumes, when more modern sources are available.

In dealing with so large a body of evidence, it is inevitable that many controversial points should be touched upon, and reference to a few of these may be made. There are also a few cases of apparent contradiction, and some errors of statement. Thus in the chapter on food areas, the squash is said (p. 18) to be cultivated in the northern half of the eastern maize area, whereas in the list of "Plants Cultivated by the Natives of the New World before 1492" (p. 20) the area of cultivation is given as "tropical America." Again, on p. 12, the original inhabitants of the Guanaco Area are said to have used the lasso in hunting, although later (p. 35) this instrument is declared to have been invented only after the introduction of the horse by Europeans. In showing the distribution of tailored garments (Fig. 23) it is somewhat doubtful whether the areas occupied by the Montagnais and Nascope in Labrador, and by the Micmac in the Maritime Provinces, should be included. In Fig. 24, showing the distribution of types of footwear, the considerable use of the sandal in the southeastern states is not indicated. On p. 111 in describing the houses of the Californians, a somewhat incorrect impression is given, for the large and solidly built semi-subterranean, earth-covered lodges which were typical of much of the Central Californian region, are not referred to. In discussing the distribution of the grooved axe, its occurrence in South America is said to be limited to Ecuador, whereas it occurs outside this region, from northwest Argentina to Guiana.

In Chapter XIV., in discussing the several culture areas, Dr. Wissler is right in saying that the Eastern Woodland Area is one of which the "characterization is difficult." Granting this, it seems somewhat dubious to select the Central Algonkin group as the type, for if the northern is to be thrown out because of its similarities to the Mackenzie Area, the Iroquois and the Eastern because of southern influence, this geographically smallest portion lying southwest of the Great Lakes is equally disqualified by this same

southern influence as well as that of the Plains. The fact is, that the convenient lumping together of all the tribes of the northeast of the continent in one area can hardly be justified, and this region, territorially great and culturally quite varied, must be split up if we are to keep true to the facts. A similar difficulty arises in the attempt to bring all the peoples of the southern tip of South America together in one area. This involves the collocation of such different types as the Yaghan and Alikaluf, with the Araucanian and Guycuru, tribes which had little or nothing in common except the fact that they were non-agricultural.

Similar questions may well be raised in regard to Archeology. Thus it is not clear why the extreme southwest corner of the North Atlantic Area should be taken as the type for the whole region, when a large proportion of the characteristic elements given are demonstrably even more typical of the areas to the west and south. The map (Fig. 76) again, does not agree with the text in the limits given to the South Atlantic Area. The discussion of the Mississippi-Ohio Area is quite inadequate, as no attempt is made to give an idea of the more characteristic and peculiar types of mounds and earthworks in the Ohio Valley. In areas XIX. and XX. no mention whatever is made of the very abundant and characteristic well and chambered graves, whose importance in relation to cultures north and south is considerable, and which constitute perhaps the most striking single feature of this whole region.

In the chapter on linguistic classification, it is most unfortunate that a number of serious errors have crept into the map, Fig. 87, reproduced from that of Chamberlain, whose initials are incorrectly given. In Dr. Wissler's map five stocks given in his list are entirely omitted, viz., the Corabecan, Curacanecan, Mainan, Puquinan, and Sanavironan; the following stocks are wrongly placed, No. 55, Ocoronan should be 65, Puquinan; No. 33, Enimagan should be 32, Curucanecan; No. 15, Canichanan should be 55, Ocoronan; No. 18 Caririan (in Northern Bolivia only)

should be 15, Canichanan. Errors of this sort seem rather inexcusable, when the map is merely a direct copy of Chamberlain's original.

In Chapter XIX., in speaking of the "migration factor," the author makes statements for which it seems difficult to give any justification. He says (p. 335) "migration is exceptional" and that when migrations do occur, "they all . . . are circumscribed movements in a single area." To speak of migratory movements extending over thousands of miles, as in the case of the Eskimo, Athabaskan, Tupi, Arawak, Carib, etc., as "circumscribed" is in itself rather staggering, but to declare that such movements of peoples were confined to a "single area" is simply a gross mis-statement of fact. If by "area" is meant "culture area," the cases of tribal movement from one to another are too numerous and too well known to need mention; if, as the remainder of the paragraph seems to indicate, Dr. Wissler means by "areas," regions of similar environment, the instances of transgression of these bounds by migrating tribes are still numerous. To take but a single case: just how does the author propose to make the known distribution of the Siouan tribes fit with his statement? Certainly the Biloxi of the sub-tropical Gulf coast, the Totero, Sara and Monacans of the Alleghanies of Virginia and North Carolina, the Crow of Montana and the Winnebago of Wisconsin can hardly be said to have been living in a "single area"!

A last word of criticism may perhaps be allowed in regard to the map at the end of the volume, showing the location of the more important North American tribes. There is no statement anywhere as to the date or period represented, but it is to be assumed that the intention was to show the locations at the time of the first European contact. If so, the map contains numerous errors. Thus the Ojibwa are shown far out in the plains west of Lake Winnipeg, while the Cree are extended almost to the base of the Rocky Mountains. These positions are certainly not those given by the earliest accounts which we have of these tribes, which are there con-

sistently placed much further to the east, and entirely outside the plains. One must also ask on what authority the Kickapoo are placed in southern Indiana, the Timuquana in southern Florida, the Arikara to the north of the Mandan, the Shasta in northeastern California and Nevada, the Quinaielet on the Oregon coast and the Tillamook in the Willamette Valley? These locations, so totally at variance with the accepted positions of these tribes, can only be due to carelessness in preparing the map, or to quite revolutionary new data which have come into Dr. Wissler's possession. Of the misprints noted, the following are the most important: p. 45, *asolepias* for *asclepias*, *apocyrum* for *apocynum*; p. 104, *rooms* for *roofs*; p. 182, *Guatavita* for *Guatavita*; p. 229, *Chaponec* for *Chiapanec*; p. 273, *northeast* for *northwest*; p. 292, *Hokan* for *Penutian*; p. 231, *Lecan* for *Changoan*.

The great excellence and value of Dr. Wissler's book, however, must not be thought to be impugned by these stray criticisms. He has accomplished a difficult task with conspicuous success, has drawn for us the first adequate picture of the aborigines of the whole of America, and has given us a volume to which specialist and layman alike may turn with confidence that they will find in it the latest results of study in this field, admirably arranged and clearly stated. To all who are in any way interested in the original Americans, the book will be indispensable.

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SPECIAL ARTICLES

MASS MUTATION IN ZEA MAYS

THE principle of mass mutation, proposed by Bartlett on the ground of his researches on *Oenothera Reynoldsii* and *O. pratincola*, seems to me to be one of the most fertile discoveries made in the experimental study of the origin of new characters. In *O. Reynoldsii* the two first artificial generations were almost uniform, but in the third a splitting occurred, producing about 40 and 23 per cent. of two

new types, which were called *semiata* and *debilis*. In *O. pratincola*, which in a number of strains is constant with some stray mutations, one strain produced in the third generation four different types, called *formosa*, *albicans*, *revoluta* and *stricta*. The total percentage of these amounted to about 75 per cent.

In order to explain this sudden appearance in such large numbers Bartlett assumes that the fundamental mutation occurred in only one of the two gametes in a generation preceding the one in which the diversity became manifest. In the next generation it was masked by the dominance of the character transmitted through the other gamete. Segregation then occurs in the following generation and it bears a certain degree of resemblance to Mendelian segregation. But whereas the law of Mendel applies to hybrids between different species, varieties or races, here the splitting occurs within a single experimental pure line. The law of probability holds good for both cases, but the starting points are different. Mutational segregation is directly concerned with the origin of a new character, but Mendelian segregation assumes the pre-existence of all unit-characters involved. It should be remarked, however, that mass mutation is not necessarily limited to such cases, but may prove afterwards to embrace other types also.

It is now generally conceded that mutations take place ordinarily in the production of the sexual cells, some time before fecundation, probably at the time of synapsis. From this conception the conclusion directly follows that the copulation of two similarly mutated gametes must be rather rare. Far more frequent must be the instances in which a mutated sexual cell combines with a normal one. The first-named cases produced the full mutations, and the types with a doubled number of chromosomes, called *gigas*, are the clearest instances. Such forms have occurred in *Oenothera Lamarckiana*, *O. stenomeris*, *O. pratincola*, *O. grandiflora* and others. The individuals, due to the combination of mutated with non-mutated gametes may be called half mu-

tants. In nature, where, as a rule, mutations are very rare, the chance for the occurrence of full mutations is mostly too small, and stray novelties, found in the field, must generally have originated in the indirect way of half mutants followed by mass mutation. This would, at the same time, explain why they are so often met with in two or more individuals.

Half mutants may differ externally from the strain, which produced them, as *e. g.*, in the case of *Oenothera rubrinervis*, or may fail to show such visible marks, as in that of *O. Lamarckiana gigas mut. nanella*. In both cases they will give rise to the full mutant in relatively large numbers in the second generation. The full mutant of the first instance is designated as *O. mut. deserens*, and that of the second is represented by dwarfs with the flowers, foliage and nuclei of *O. gigas*. They occur in about 20-30 and 15-18 per cent. among the offspring of the original half mutants.

In a strain of ordinary corn, which I cultivated for other purposes, an instance of mass mutation has occurred which evidently requires the same principle for its explanation. The mutants have been described under the name of *Zea Mays sterilis* and figured in Vol. I. of the *Botanisch Jaarboek* of the Society Dodonæa at Ghent in Belgium. They are devoid of all branches. No lateral stems, no ears, no ramifications of the spike and no male flowers are produced. The whole plant is a barren stem with a naked spill instead of an inflorescence. They are built in the same manner as the unbranched fir, *Pinus Abies aelada*, described and figured by Schröter.

I cultivated my strain after a simple method, sowing each year the seeds of a single ear, planting the seedlings on sufficient distances to insure a high degree of self-fertilization and eliminating the individuals produced by stray crosses by means of vigorous selection. No unbranched specimens occurred during the six first years. In the seventh generation, however, they appeared unexpectedly and in 40 specimens among 340. This indicated a percentage of 12, which is far

higher than the ordinary mutability in *Linaria*, *Chrysanthemum*, *Oenothera a. o.* (mostly 1-2 per cent.). Besides these unbranched plants some intermediate forms were seen, with incompletely developed ears and spikes. I chose one of these for the continuation of the race and had, next year, a generation of 57 individuals eleven of which belonged to the new type. The percentage figure was 19, giving new proof of the occurrence of mass mutation.

If we assume a sexual cell of the fifth generation to have mutated into the unbranched character, and to have combined with a normal one, the sixth generation may have included a half mutant of the new type, which could not be discerned at the time, since it was wholly unexpected, but was chosen by chance. Segregating after the principle of Bartlett it could have produced 25 per cent. of sterile individuals, besides 50 per cent. of half mutants with more or less incomplete ramification. These would repeat the splitting in the following generations. Had I known that principle at the time, I would surely not have given up the culture, as I did.

In the production of other sterile varieties the principle of mass mutation must have played a similar rôle. They can not evolve through the slow accumulation of small useful deviations, and their chance of arising at once as full mutants must be very little. Double flowers of the petalomanous type are well-known instances. I once found such a mutation of *Ranunculus arvensis* in a meadow, and the corresponding variety of *Caltha palustris* is cultivated in gardens, where it propagated in the vegetative way.

Yellow seedlings, which die after unfolding their seed-leaves, are another instance, and for these the mutational percentages are easily ascertained. They are often high enough to give proof of the presence of mass mutation. I found 25 per cent. for *Linaria vulgaris*, 15-30 per cent. for *Papaver Rhæas*, 10-15 per cent. for *Scrophularia nodosa*, 9-13 per cent. for *Clarkia pulchella* and about 10 per cent. in some other instances.

Mass mutation must be quite common in

nature. It is probably the ordinary way in which white-flowered, hairless and spineless varieties and so many analogous novelties are produced in the field and in horticulture. The experimental instances seem quite sufficient and broad enough to establish the principle, but as yet they belong almost to the retrogressive mutations. The claim that progressive changes are also due to sudden mutations still mainly rests on our theoretical conception of the evolution of organic life in general. But, fortunately, some experimental evidence is coming in of late for this point also.

HUGO DE VRIES

LUNTEREN, HOLLAND

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION E—GEOLOGY AND GEOGRAPHY

THE sixty-ninth meeting of Section E (Geology and Geography) of the American Association for the Advancement of Science was held in the auditorium of the new U. S. Bureau of Mines Building in Pittsburgh, Pa., on December 28 and 29. Professor George H. Perkins, vice-president of Section E, presided.

The general program, of which abstracts follow, was so full that each session far overran the usual time limit. Geological workers from the general Pittsburgh region contributed much to the success of the meetings.

The address of the retiring vice-president, Professor Rollin D. Salisbury, of the University of Chicago, upon the subject, "The educational value of geology," was given on the afternoon of December 28, and was printed in *SCIENCE*, April 5.

On the morning of December 29, a symposium entitled "Mineral resources and chemical industry" was held jointly with Section C. This was essentially a war-time session dealing with the peculiar problems now facing this country as the result of the war, the unusual demand for certain materials and products, and the necessity of relying upon the country's own reserves and industries for various materials formerly imported in large measure from sources not now available. The papers upon mineral resources described in detail the special efforts now being made by the U. S. Geological Survey and the U. S. Bureau of Mines to solve the problem of supplying the country with the necessary fuels, potash salts and metals (such

as tungsten, chromium, nickel, cobalt, vanadium, manganese, etc.) which are required for the successful prosecution of the war. The papers on chemical industries portrayed some of the efforts put forth by the chemists in response to certain urgent needs and special situations developed by war conditions.

The Symposium comprised the following papers:

1. Introduction to the discussion of our mineral reserves under war conditions: David White.
2. Coal, coke and tar distillation: S. W. Parr.
3. The bearing of the oil industry on the war: C. H. Beal.
4. Glassware, with special reference to chemical glassware: S. R. Scholes.
5. Potash production in the United States: W. B. Hicks.
6. Research in chemistry and metallurgy as applied to non-ferrous metals: C. H. Fulton.
7. Domestic resources of ferro-alloy ores: D. F. Hewett.

These papers will be published in another number of *SCIENCE*.

Dr. David White, of the U. S. Geological Survey, was elected vice-president of the association and chairman of Section E for the coming year; Dr. Wallace W. Atwood, of Harvard University, member of the council; Dr. George F. Kunz, of New York, member of the General Committee; Dr. George F. Kay, of the University of Iowa, member of the sectional committee to serve one year in place of Dr. David White, resigned, and Dr. L. C. Glenn, of Vanderbilt University, member of the sectional committee for five years. To represent Section E at the celebration in honor of the one hundred and seventy-fifth anniversary of the birth of Abbé René Just Haüy, to be held at the American Museum of Natural History, New York City, on February 28, 1918, there were appointed by the chairman Dr. E. C. Hovey, Dr. C. P. Berkey and Dr. J. E. Woodman.

The titles and abstracts of the papers of the general program follow:

Glass sands: CHAS. R. FETTKÉ (will be printed in *SCIENCE*).

The Saltsburg sandstone as a building stone: S. B. BROWN.

The rapidity with which the Saltsburg sandstone gained favor may be seen from the number of important structures in which it has been used during the last six years. A few of these are the following: The Cabin John bridge at Washington City, some interior work in the Grand Central Rail-

road Station, New York City, the Russell Sage Memorial Building, the synod house of the Cathedral of St. John the Divine, the interior finishing of the Jersey City postoffice. It has been used also in the new postoffices at Morgantown, Grafton and Sistersville, and in the Presbyterian Church at Fairmont, West Virginia. It has been used in the United States Aluminum Clubhouse at New Kensington, Pennsylvania; in the W. W. Willock residence at Sewickley, the Inslie Blair residence at Tuxedo, and in the finely finished Stewart Duncan residence at Newport, Rhode Island. This last has been described as one of the masterpieces of American architecture. A still more artistic use to which it has been put is in the case of the elaborate mantels at the New Kensington Clubhouse and also the mantel in the Mulligan residence in Pittsburgh. The artistic carving and the statues on the Schwab estate, and the buffaloes and the Indian heads on the Cabin John bridge show some of the finer uses to which it lends itself. This would indicate that a new building stone of singular beauty has caught the favor of the public for refined uses, and its future popularity may be predicted with some degree of confidence. Its strength is sufficient for any purpose to which it is likely to be put, tests showing a crushing strength of 9,000 to 11,000 pounds to the square inch having been made. Its chemical composition runs thus: Silica, 96.50 per cent.; ferric iron, 1.76 per cent.; alumina, .86 per cent.; lime, .35 per cent.; magnesia, .02 per cent. It would therefore be graded as a sandstone of moderate purity with its iron cement very evenly distributed through it. Professor Stevenson probably never saw the localities of its best development, but the success of this stone forty years after reminds us of his statement, in which he calls it "a magnificent rock, in layers ten to fifteen feet thick, most of which are of excellent quality and would prove a durable building stone." Although he could hardly have foreseen the finer uses to which the Saltsburg sandstone has been put, nevertheless Professor Stevenson was a true prophet, as every geologist must be who writes only the truth.

The compilation of coals: REINHARDT THIESSEN.

A complete and correct explanation of the meaning of the bright or glanz and dull coal, and an interpretation of the lamination of coal in general has never been given. In spite of many theories and attempts at explanations the matter is still in a state of confusion. Extensive studies have shown that the bright or glanz coal consists invariably of components derived from matter that

at one time were larger fragments or parts of woody parts of plants, such as parts of logs, stems, branches and roots. These correspond in every respect to the parts of logs, branches and roots in peat. The dull coal represents a general débris of plant substances, and consists primarily of components derived from fragmentary parts, or chips of the woody parts of plants, and fragmentary matter derived from various other parts and organs of plants, embedded in or cemented together by an attritus, together forming the embedding medium of the larger components or bright coal. The attritus consists of what at one time was very finely macerated plant matter and corresponds in every respect to the fine "mud" in peat. The components derived from the fragmentary woody parts of plants are generally very thin and scale-like and owe their peculiar shape and form to a mode of disintegration through lesions along the annual growth rings, and along the rays, caused by a differential decay during the peat stage. This phenomenon finds an exact counterpart in recent peat.

The travertine deposits of the Arbuckle Mountains, Oklahoma, with reference to the plant agencies concerned in their formation: W. H. EMIG.

At the present time there is a continuous development of travertine on the numerous falls along two parallel streams in the Arbuckle Mountains, namely Honey Creek and Falls Creek. The development of the travertine falls is due in part to the presence of felt-like masses of algæ—species of *Ædogonium* and *Vaucheria*, also *Oscillatoria* and *Lyngbya*—and in part to the presence of aggregated tufts of the water mosses, *Philonotis calcareus* and *Didymodon tophaceus*. The various types of travertine, formed as a result of the continuous growth of certain plants in the calcareous water, are quite characteristic. The similarity in the microscopic structure of recent and older deposits of travertine is very striking. A comparison of the newly formed deposits with the oldest travertine of the Arbuckle Region indicates that the same plant agencies were concerned in the construction of all the travertine formations in Oklahoma.

The Kanawha black flint and other cherts of West Virginia: W. ARMSTRONG PRICE.

Ten Paleozoic formations contain deposits of chert (or flint). The cherts are found in silicious and magnesian members of limestones and calcareous shales. Limestone-bearing formations ap-

parently barren in chert are: the Silurian formations, and limestones in the upper portion of the Pennsylvanian. The Greenbrier limestone is notably poor in flint. The Kanawha Black Flint occurs in two lithologic phrases—a high-silica, low-alumina, compact phase, and a phase slightly lower in silica and higher in alumina which has a "slaty" structure. Fossils of species which possess lime shells have been leached out before the deposition of the silica. Replacement of calcium carbonate has played an unimportant rôle in the formation of the flint. Depositions of silica by descending surface waters in the pores of a carbonaceous and highly silicious rock has resulted in the formation of a dull, black, compact chert or flint. Absence of original silicious ooze is inferred but not proven. Tilting of the strata has enabled solutions to migrate along the dip, increasing silification. The black flints of the Pennsylvanian were used by the Indians in the manufacture of arrow heads and implements. They have been scattered over many counties beyond the flint outcrop. Flint from limestone formations often contains sufficient lime to form a compact surface when used in road building. Chert beds in limestone valleys form ridges upon which apples and berries grow especially well.

The determination of the stratigraphic position of coal seams by means of their spore-exines:
REINHARDT THIESSEN.

There has thus far been found no index by means of which coal from different mines or from different bore holes may be correlated, or by means of which the position of a seam may be determined. The spore-exines in coal promise to furnish such an index. The coal from every seam, thus far examined, contains one or more types of exines that are characteristic or predominant or both of each bed, by means of which the coal may readily be identified and the position of its bed be determined. Spore-exines are very prominent in coal, are easily recognized and have retained all their original characters by means of which each type may easily be defined. The coal of the Pittsburgh seam contains at least one type of exine that is both predominant and characteristic of that seam. Similarly the coals from Sipsey, Alabama, Black Creek bed; Carbon Hill, Alabama, Jugger bed; Shelbyville, Ill., bed No. 2, and from Buxton, Ia. Each contains at least one type that is both the predominant and the characteristic exine. Some of these have, besides these, at least one other type that is characteristic of the seam, although not the predominant one. Bed No. 6, of Illinois,

contains at least one type that is characteristic of that bed, and probably more.

The Holmesville, Ohio, glacial terrace and moraine:
G. G. COLE.

The village is situated on a large terrace surrounded on all sides by low ground, with a swamp separating it from the recessional moraine half a mile south. The terrace is very steep on the north and while quite flat slopes gradually to the south. Well-washed coarse gravel is found on the northwest higher corner, the southern being fine material and sand. A peculiar arrangement occurs in the terrace: gravel of 74 per cent. local origin at the top, a belt of large boulders at a mean depth of 8 feet, mostly granitic, with fine gravel and sand beneath. This indicates a complicated origin for the terrace. The moraine is a recessional one, located five miles back from the terminal moraine at Millersburg, Ohio. It is of great size and likely to be overlooked as a glacial feature on that account. It is crescent-shaped with concave side toward the Holmesville terrace, having its two horns west and northeast of the terrace a mile apart. Numerous kettles with a kettle pond are found on its surface and border. These have been well preserved by virgin forests recently removed. Drift material 31 per cent. foreign, some Corniferous limestone from Lake Erie region being found. The terrace structure is accounted for by supposing an impounded lake between the moraine and a stage of ice recession to present site of north edge of terrace. The lower layers of terrace derived from the sediment of this lake; the boulder bed from the melting of the receding ice. The subsequent drainage of the lake around the western horn of moraine, caused the debris to collect in front of the face of ice and increased by material brought out from an interglacial tunnel at northwest corner of terrace, involving an outwash plain distributed as upper surface of the terrace. Steep sides caused by a rapid abandonment of the valley north of the terrace.

Diverse ancestry of great basin lakes: CHARLES KEYES.

Explanation of the former existence of desert lakes of great size in western America on the basis of once greater regional humidity becomes notably inadequate when it is realized that hardly any two of these vast sheets of water have had the same origin. Recent quantitative measurement of neighboring glaciation renders this agency a singularly inconsequential factor. All things considered it is inferred that the rise and decline of these great lacustral anomalies of the western arid

country are not necessary consequences of changing climate, but that they, with all their attendant phenomena, are readily accounted for without recourse to meteoric agencies other than those in active operation in the region at the present time. The genesis of these desert lakes is as varied as that of lakes in the garden spots of earth.

Some economic mineral deposits of east Tennessee:

C. H. GORDON.

Superficial dip of marine limestone strata: KIRTLLEY F. MATHER.

Petroleum geologists have long recognized the necessity of distinguishing between the inclination of beds due to purely surficial causes and that resulting from crustal deformation. The latter only is indicative of the underlying structure. Limestones may depart from horizontality as a result of groundwater action assisted by gravity. The apparent dip thus caused may extend uninterruptedly for considerable distances along hillsides and may closely simulate folded structures. Examples will be cited from the Ordovician limestones of Ontario and from the Mississippian limestones of Kentucky. The dip of limestone beds, as of all sedimentary formations, conforms originally to the slope of the floor upon which the bed is deposited. This floor may be quite irregular, as in the case of the pre-Cambrian complex upon which rest the Ordovician limestones of eastern Ontario. Quaquaversal structures in certain limestones near Kingston, Ontario, are due to deposition of those essentially clastic limestones upon the flanks of granite or gneiss hills rather than to tectonic disturbances. Submarine erosion contemporaneous with the accumulation of clastic limestones may repeatedly roughen the sea-floor and result in the development of cross bedding on a large scale. As illustrated by Mississippian limestones in Allen county, Kentucky, original dips as great as 12° have thus been caused. Their correct interpretation may be deduced only when the exposures are unusually extensive and perfect.

On the mechanics of the great overthrusts: ROLLIN T. CHAMBERLIN.

In the literature of structural geology it is commonly stated that thrust faulting under compressive stress tends to take place along planes which are inclined approximately 45° to the direction of the applied force. With qualifications, this is true of the ordinary reverse fault. But field studies in the last few years have brought to the attention of geologists impressive evidence of the wide prevalence of a distinctly different type of fault,

namely the great low-angle overthrust. Its distinguishing characteristics are the very low inclination of the fault plane and the extraordinary horizontal displacement often attained. The astonishing amount of horizontal displacement is possible because of the low inclination of the plane of slippage which shows no tendency to obey the law of 45° fracture. The low angle of the fault plane seems to afford the key to the problem of the overthrust. An analysis based upon the principles of mechanics, aided by experimental studies with plaster, paraffine, clay and sand in various combinations, seems to indicate that the fault plane in the great overthrusts breaks horizontally, instead of at 45° , because of the operation of a number of factors, chief of which are: (1) The normal or direct component of the stress which acts as a frictional resistance to shearing by the tangential component of the stress. With a lowering of the angle of fracture from 45° , the intensity of this frictional resistance is diminished more rapidly than is the intensity of the tangential, or shearing stress. This makes fracturing easier at angles somewhat less than 45° , though the fault plane remains still far from horizontal. (2) Rotational strain, developed from compressive stress (a) in heterogeneous material by bedding, or similar structures, which present just the right differences in competency; (b) in homogeneous material by (1) any increase in the intensity of the tangential stress in the upper portion of the mass undergoing thrusting with respect to that in the lower portion; (2) by any factors which will lessen the resistance of the surficial portion while the deeper portion remains less affected, and (3) by any factors which will increase the resistance of the deeper portion subject to thrusting, while the upper portion remains freer to yield. Rotational strain is competent to cause fracturing at any angle between 45° and 0° , depending upon the strength of the rotational element. (3) Piling up of material in the first stages of deformation, thus increasing the gravitative or vertically acting force. Acting in conjunction with the horizontal thrusting force, this may cause a lowering of the angle of fracture. (4) Possible minor factors, as heterogeneous material, relatively great length of deformed mass (after analogy of long column), shape, etc. To these factors, operating singly or in various combinations according to the special requirements of each particular case, are attributed the peculiarities of the great overthrusts.

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(To be concluded) Secretary